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Rural Sewage Disposal

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Rural Sewage Disposal

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This circular outlines the basic principles of design, construction, installation, and maintenance of a septic tank and subsurface disposal system for rural residences where public sewers are inaccessible or impractical.

Rural Sewage Disposal

A sanitary sewage disposal system is necessary to dispose of human excreta in rural homes where public sewers are not available. Sewage wastes, if not properly disposed of, are dangerous because they contain living bacteria and viruses, some of which are of disease-producing types. For this reason, every effort should be made to prevent health problems and to dispose of all human wastes so that no opportunity will exist for contamination of water or food.

Connection to an adequate public sewage works system is the most satisfactory method of disposing of sewage. Every effort should be made, therefore, to secure public sewer extensions, particularly in areas near organized municipalities. When a considerable number of residences are to be served and a public sewer is not available, consideration should be given next to the construction of a community sewage collection system and treatment plant. Information on development of community systems can be obtained from the State Department of Health.

Proper disposal of all human and domestic wastes not only will protect the health of the individual family and the community but will prevent the occurrence of nuisances.

By **Louis Lubinus,** Extension Agricultural Engineer, South Dakota State College, and **Don C. Kalda,** Assistant Director, Division of Sanitary Engineering, South Dakota Department of Health

Such wastes must be disposed of so that:

1. Water supplies will not be contaminated.
2. Public health hazards will not be created by being a breeding place for insects, rodents, and other possible carriers which may come in contact with food and drinking water.
3. A health hazard will not be created by being accessible to children.
4. State or local regulations governing water pollution and sewage disposal will not be violated.
5. Waters used for recreational purposes will not be polluted.
6. A nuisance resulting in obnoxious odors or unsightliness will not be caused.

Along with a safe and adequate pressure water system and adequate plumbing, a sanitary sewage disposal system will make housework easier and provide greater comfort and convenience for the rural family. Good planning will insure having the most satisfactory installation for the rural home and one which will work properly for many years.

SEWAGE FLOWS

Systems are generally designed on the basis of a sewage flow of 50 gallons per person per day or 100 gallons per bedroom. Judgment must be used in estimating present and future possible usage of the system. The usual design method is to use the number of bedrooms with at least two persons per bedroom. If more than two persons occupy a bedroom, or if other rooms are used for sleeping, take these factors into consideration in designing the system.

All wastes from the household, including those from the laundry, bath, and kitchen should discharge into one system. A grease trap for the kitchen wastes is not necessary. The discharge from a garbage grinder should never be passed through a grease trap but should be run directly into the septic tank. The septic tank capacities recommended are sufficient to handle the grease normally discharged from a home.

Waste brines from household water softener units have no adverse effect on the action of the septic tank, but may cause a slight shortening of the life of a disposal field installed in certain clay-type soils. Under normal conditions, these wastes may be directed to the sewage disposal system.

Roof drains, foundation drains, and drainage from other sources producing large amounts of clear water should not be piped into the septic tank or absorption area. Drainage from garage floors or other sources of oily wastes should not be discharged directly into the system. Provide a grease and sand trap for such wastes prior to discharge into the septic tank.

HOUSE SEWER

The house sewer is that part of the horizontal piping extending from the foundation wall of the building to the septic tank. It should be constructed of 6-inch diameter, tight jointed pipe of cast iron, clay, asbestos cement, plastic, or bituminous pressed fiber. Any portion of the sewer line within 50 feet of a well or within 10 feet of any drinking water supply line under pressure should have watertight joints.

Lay the sewer on firm soil at a grade of at least one-fourth inch per foot and without any bends. Adequate venting is obtained through the building plumbing if the plumbing and septic tank are designed and installed properly. A separate vent on the septic tank is not necessary.

SEPTIC TANK

Purpose

A septic tank is a watertight structure in which organic solids and liquids are subjected to decomposition by bacterial and natural processes. The flow of sewage from the house is retarded in its passage through the tank so that the larger solids will settle to the bottom and accumulate as sludge. The finer particles will remain in suspension and pass out of the tank with the liquid. Scum and other floating solids are retained in the tank by the use of baffling devices.

The bacteria present in a septic tank are a variety which thrive in the absence of free oxygen. Decomposition in the absence of free oxygen is termed "septic," from which the name of the tank was derived. The solids and scum are digested and reduced to a smaller volume; however, a residue of inert solid material will remain. Space must be provided in the tank to store this residue during the interval between cleanings.

The overflow from the septic tank will contain large numbers of harmful bacteria and organic matter in a finely divided state or in solution. Foul odors, unsightly conditions, and serious public health hazards will result if this overflow is discharged to the ground surface. Final disposal of the liquid in a soil absorption system is necessary to alleviate these problems. A septic tank does not provide complete sewage treatment.

Location

Locate septic tanks where they cannot cause contamination of any well, spring, or other source of water supply. The tank should be at least 50 feet away and downhill from a source of water supply.

Do not locate the septic tank within 5 feet of any building, in swampy areas, or in areas subject to flooding. Also give consideration to the location from the standpoint of cleaning and maintenance.

Capacity

Ample capacity is one of the most important considerations in septic tank design. A liberal tank capacity is not only important from a functional standpoint but is also good economy. The liquid capacities shown in table 1 allow for the use of all household appliances including garbage grinders.

Table 1. Required Liquid Capacity of Septic Tanks

No. bedrooms	No. persons	Req. capacity (Gal.)
2 or less	4 or less	750
3	6	900
4	8	1,000

Design and Construction

Septic tanks should be watertight and constructed of corrosive-resistant materials such as concrete, coated metal, vitrified clay, heavyweight concrete blocks, or hard burned bricks. Properly cured precast and cast-in-place reinforced concrete tanks are universally acceptable. Prefabricated coated metal tanks should meet Commercial Standard 177-51 of the U. S. Department of Commerce and be labeled with the Underwriters Laboratories seal. The interior of concrete block and brick tanks should be surfaced with two one-fourth inch coats of portland cement sand plaster.

Other features of properly designed and constructed septic tanks follow:

1. The shape of a septic tank is relatively unimportant. Generally the length of rectangular tanks should be approximately twice the width. Circular and cylindrical tanks function as well as rectangular tanks.

2. A single compartment tank is satisfactory .

3. Liquid depth may range between 30 and 60 inches.

4. Provide a 12-inch space between

the liquid surface and the top of the tank.

5. Provide an access manhole or removable cover at each end of the tank.
6. The bottom of the inlet pipe should enter the tank about 3 inches above the liquid level.
7. A vented inlet tee or baffle extending at least 6 inches below the liquid level is required.
8. An outlet tee or baffle should extend 12 to 24 inches below the liquid level depending on the depth of the tank.
9. Place precast tanks on a bedding of sand or pea gravel.

A typical concrete septic tank is shown in figure 1.

Operation and Maintenance

Clean septic tanks periodically to prevent excessive accumulations of scum and sludge. If either the sludge or scum approaches too closely to the bottom of the outlet device, solids will be scoured into the disposal field and clog the system. When a disposal field is clogged in this manner, it is not only necessary to clean the tank, but it also may be necessary to construct a new disposal field. Septic tanks of the size recommended should give about 3 years of satisfactory operation before cleaning becomes necessary.

Cleaning is usually accomplished by pumping the contents of the tank into a tank truck. Individuals who conduct a business of cleaning septic tanks are located in most areas. South Dakota law requires that these persons be licensed by the State Department of Health. All properly licensed operators are issued an annual license card which the homeowner should request to see before contracting for services. The law includes no provisions for regulating charges, and it is therefore strongly recommended that a lump sum contract price be agreed upon before any work is done. Arrangements based on costs per pound, gallon, load, or hour should definitely be avoided. The cost of cleaning a 750 gallon tank under normal conditions usually ranges from $25 to $50.

Do not wash or disinfect septic tanks after pumping. A small residue of sludge should be left in the tank for seeding purposes.

The operation of septic tanks is not improved by addition of disinfectants or other chemicals. In general, the addition of chemicals to a septic tank is not recommended. Some products on the market which claim to "clean" septics tanks, thereby eliminating the need for pumping sludge, contain sodium hydroxide (lye) or other caustic compounds. Such compounds may interfere with the biological action in the tank and eventually cause clogging of the soil disposal system even though some temporary relief may occur. Soaps, detergents, bleaches, drain cleaners, or other materials normally used in the household will not appreciably affect operation of a septic tank.

Over 1,000 products, many containing enzymes and other reportedly magical ingredients, have been placed on the market for use in septic tanks, and extravagant claims have been made for many of them. Properly controlled tests have indicated that a septic tank will operate equally as well without these products.

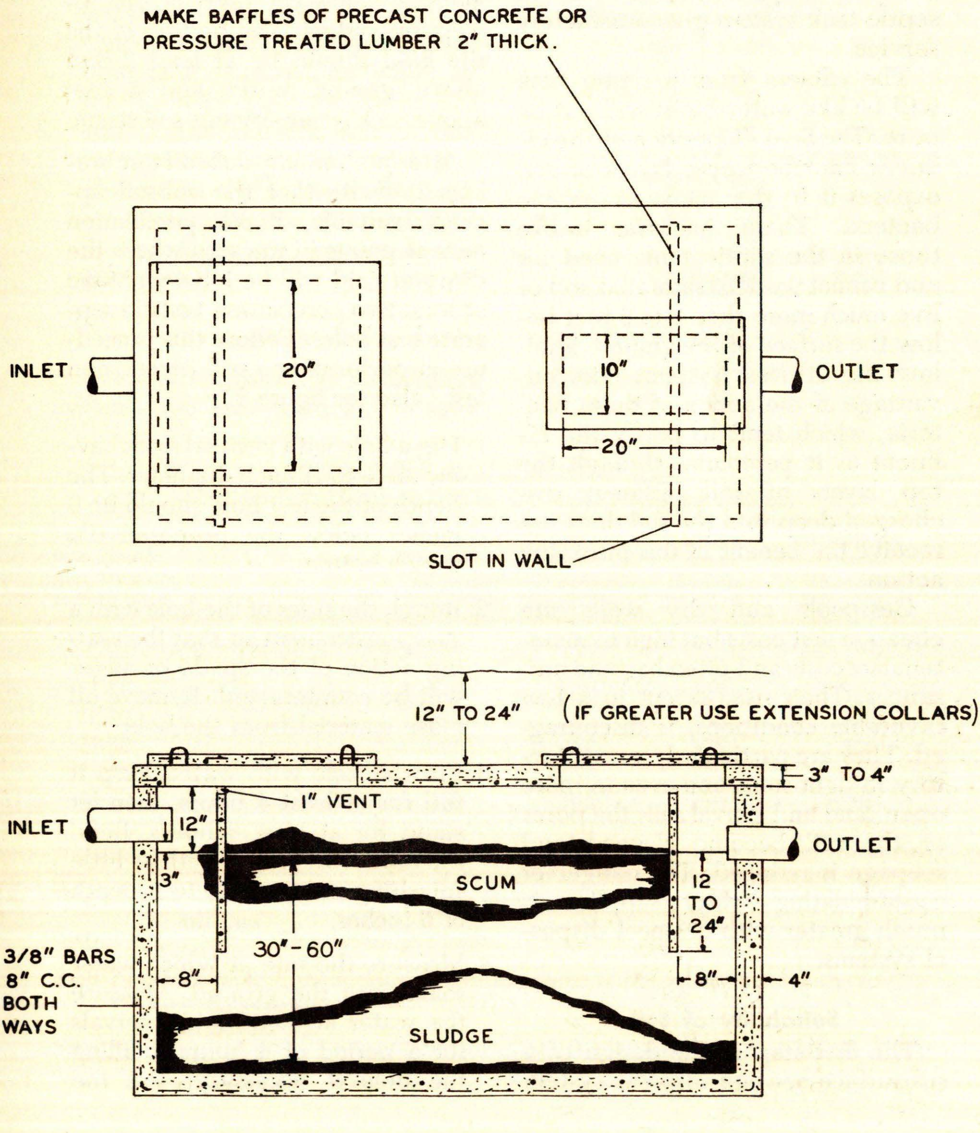


Figure 1. Typical concrete septic tank.

TILE DISPOSAL SYSTEM

Purpose

Final disposal of the effluent from the septic tank causes most of the difficulties with rural sewage disposal systems. Only when there is an adequate disposal system will the septic tank system give satisfactory service.

The effluent from a septic tank will be like water but it will not be pure. The final disposition of the effluent into the upper layers of soil exposes it to the action of aerobic bacteria. These bacteria, unlike those in the septic tank, need air and cannot work in saturated soil or live much more than 3 to 5 feet below the surface of the ground. Shallow tile disposal systems take advantage of the action of these bacteria, which tend to purify the effluent as it percolates through the top layers of soil. Effluent discharged deep into the soil does not receive the benefit of this purifying action.

Cesspools and dry wells are cheap in first costs but high in maintenance costs and often become nuisances. Their use, except in a few favorable conditions, is discouraged. They are particularly unsatisfactory in tight soils, and even in more open sand and gravel soils the pores of the soil become clogged and seepage is reduced. The danger of contaminating water supplies is much greater with cesspool disposal systems.

Suitability of Soil

The first step in the design of a subsurface sewage disposal system is to determine whether the soil is suitable for the absorption of septic tank effluent and, if so, how much tile field is required. The soil must have an acceptable percolation rate without interference from ground water, impervious soil, or rock formations below the level of the absorption system. The bottom of the tile field should be at least 2 feet above ground water and 5 feet above rock or impervious soil strata.

After preliminary subsoil test borings indicate that the subsoil appears suitable, make percolation tests at points in the area where the disposal field will be located. Make at least two percolation tests in separate test holes. Follow this procedure in performing a soil percolation test (also see figure 2):

1. Dig a hole with vertical sides having an 8- to 12-inch diameter. The depth of the test hole should be 6 inches below the proposed tile trench bottom.

2. Rough the sides of the hole with a sharp instrument so that the sealing action of the spade or auger will be counteracted. Remove all loose material from the hole.

3. Fill the hole with water, keep it full for at least 4 hours, then let stand for at least 8 hours. Refill the hole with water, with as little splashing as possible, to a depth of 6 inches.

4. Measure the rate at which water soaks into the ground. Measure the water at 30-minute intervals for a period of 4 hours, refilling the hole if necessary. Use the

drop occurring in the last 30-minute interval to determine the percolation rate. In sandy soils, take measurements at 10-minute intervals and run the test for 1 hour. Use the drop that occurs during the last 10 minutes to calculate the percolation rate.

5. Calculate the percolation rate (the time required for water to fall 1 inch) and determine the size of the tile disposal system from table 2. In the event that the absorption rate is less than 1 inch per 60 minutes, the above-ground or Nodak disposal system is recommended.

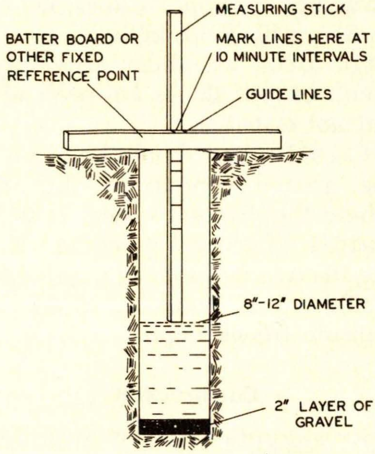


Figure 2. Soil percolation test.

Location

Keep all subsurface absorption systems 100 feet from any water-

Table 2. Required Absorption Area
(Square feet of trench bottom for trench disposal system)

Percolation rate (time in min. for water to fall 1 inch)	1-bedroom home (2 persons 100 gal/day)	2-bedroom home (4 persons 200 gal/day)	3-bedroom home (6 persons 300 gal/day)	4-bedroom home (8 persons 400 gal/day)
0- 5	40	80	120	160
6-10	60	120	180	240
11-15	75	150	225	300
16-20	100	200	300	400
21-30	125	250	375	500
31-45	175	350	525	700
46-60	250	500	750	1,000

Example: The percolation test determined that the drop in water level during the final 30-minute period was 5 inches. The disposal field is to be adequate for a 3-bedroom home, or six persons. The trench digger will make an 18-inch wide trench.

Step 1—$\frac{\text{30 minutes}}{\text{5 inches}}$ = 6 minutes per inch

Step 2—From table 2, the required absorption area is 180 square feet for the trench disposal system.

Step 3—$\frac{\text{180 square feet}}{\text{1.5 feet (18 inches)}}$ = 120 feet of disposal tile trench. Length of tile lines should be held to 100 feet or less, so two 60-foot lines would be used.

supply well, 50 feet from any stream or watercourse, and 10 feet from dwellings or property lines. Do not construct tile fields in the vicinity of large trees or under driveways. South or east slopes are preferable but not essential.

Consideration should be given to the ground contour in the area where the disposal system is to be located. The usual procedure is to dig the trenches so they parallel the contour lines, resulting in a more uniform trench depth.

Construction

An absorption field or subsurface tile disposal system is usually constructed of 12-inch lengths of 4-inch agricultural drain tile or perforated asphalt-impregnated fiber pipe laid in such a manner that flow from the septic tank will be distributed with reasonable uniformity.

Individual laterals preferably should not be over 60 feet long, with a maximum length of 100 feet. Use of more and shorter laterals is preferred because if something should happen to disturb one line, most of the field will still be serviceable.

Lay the trench bottom and tile distribution lines at a grade of 2 to 4 inches per 100 feet.

The depth of the absorption field trenches should be 30 to 48 inches in South Dakota. Freezing rarely occurs in a carefully constructed system kept in continuous operation.

Current design practice for tile disposal trenches provides for trench widths varying from 18 to 24 inches, with the tile laid on a minimum of 6 inches of clean, graded gravel or crushed stone ranging in size from one-half inch to 2 inches. The material should extend from 2 inches above the tile to 6 inches below the bottom of the tile. Cover the upper half of the joint openings with a 4-inch wide strip of tarpaper or similar material prior to covering with the gravel. Use of a liberal amount of gravel or crushed stone will increase the absorption capacity and life of the system. Figures 3 and 4 illustrate the construction of a tile disposal system.

The minimum recommended distance between tile disposal trenches is 7 feet.

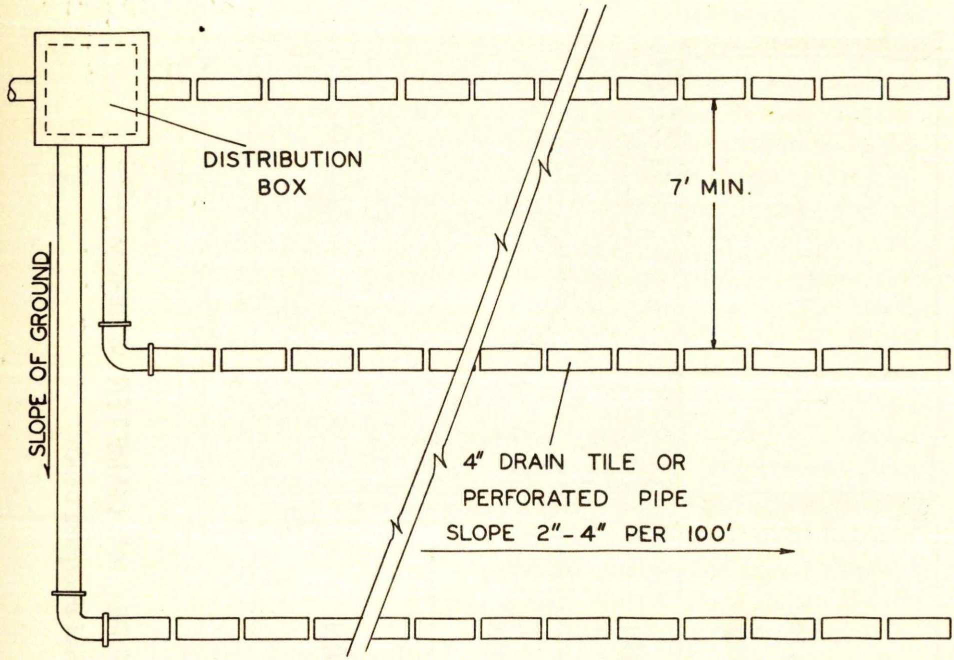
Distribution Box

A distribution box is considered essential for every tile absorption system. The purpose of the box is to distribute equal amounts of effluent to the several lateral lines. At least two lateral lines should lead from the box and enough additional laterals should be connected to the box to provide the required absorption area. Figure 5 shows a typical distribution box located between the septic tank and the absorption system.

The setting and connection of the distribution box are extremely important. The box must be set so it is firmly placed and all outlets are at the same level. The purpose of having outlets slightly off the bottom is so a small amount of water placed in the box can be used in leveling the outlets.

Maintenance of Disposal Fields

It is desirable to provide a grass cover over the disposal area. Prevent puddles of storm water from



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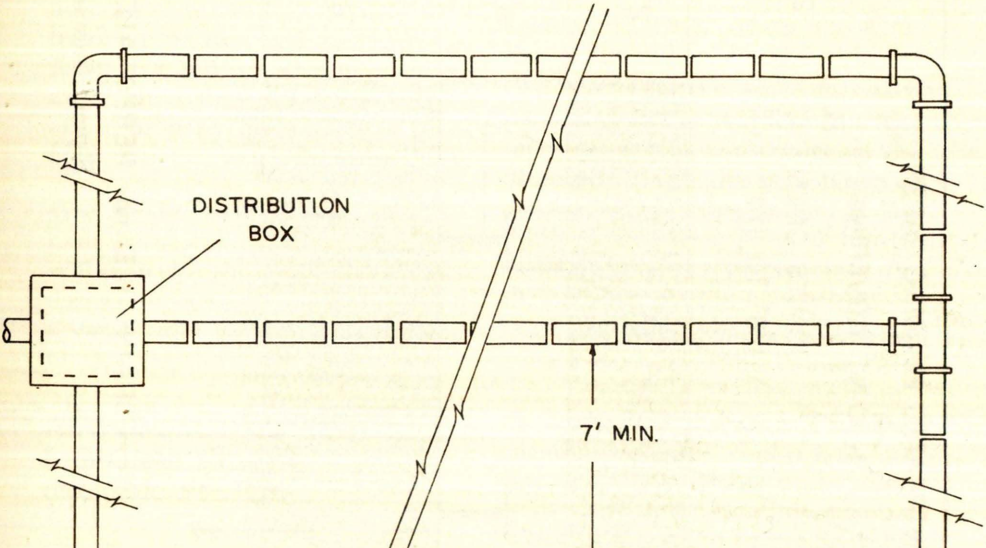

B

Figure 3. Absorption field systems—A for sloping ground, B for flat ground.

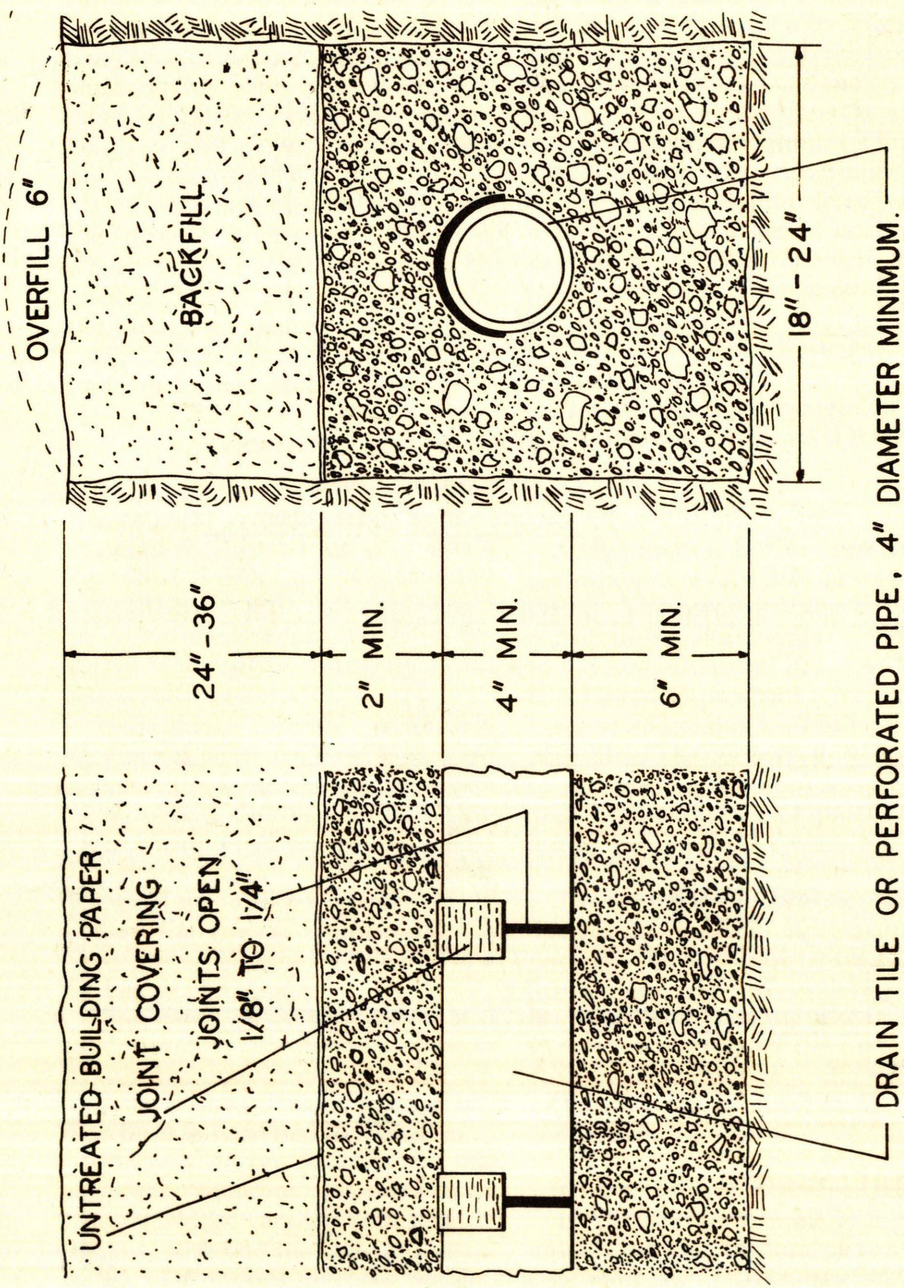

Figure 4. Cross section of absorption trench.

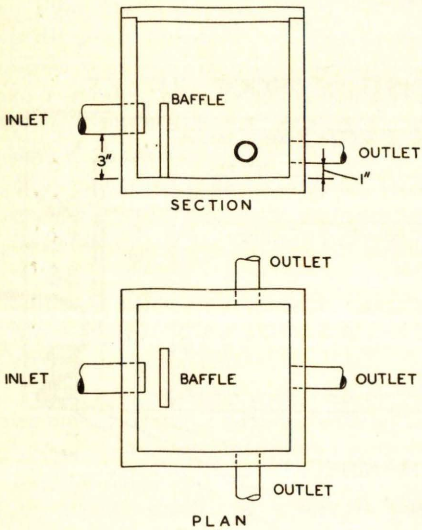

Figure 5. Typical distribution box.

accumulating on the disposal field by diverting rain and melted snow. Keep roof and foundation drainage away from disposal fields. Above all, to properly maintain a disposal field and to assure its longer life, clean the septic tank when necessary. Sludge carried over the effluent from a neglected septic tank will soon clog the disposal field. The cost of replacing a disposal field is several times greater than the cost of cleaning the septic tank.

ABOVE-GROUND SEWAGE DISPOSAL SYSTEM (NODAK SYSTEM)

Description

The above-ground sewage disposal system, also known as the Nodak System, is particularly suitable where the soil is extremely tight or where the ground water table is high. The name "Nodak System" was applied to the system by its developers at North Dakota State University. Numerous installations of this type have been made in North Dakota and South Dakota, and reports indicate the system operates satisfactorily even under difficult soil and ground water conditions. The system may be used in any type of soil, and the choice of disposal system becomes largely dependent on the relative costs of construction.

A shallow disposal field has several advantages for liquid disposal in tight soils. Surface soils will usually absorb more water than subsoils, and bacteria and other organisms are much more active near the surface. Bacterial action and aeration of the soil are important in decomposition of the waste materials remaining in the overflow from the septic tank. Grass growths on the disposal bed will also use up part of the water by transpiration. If the disposal field does plug, it can be easily cleaned or replaced since it is shallow and readily accessible.

A conventional septic tank is required as a part of this system, as it is for all systems. The overflow from the septic tank flows into a holding chamber near the septic tank. An automatic submersible sump pump is installed in the holding chamber to pump the liquid to the final disposal field. Figure 6 shows a typical installation.

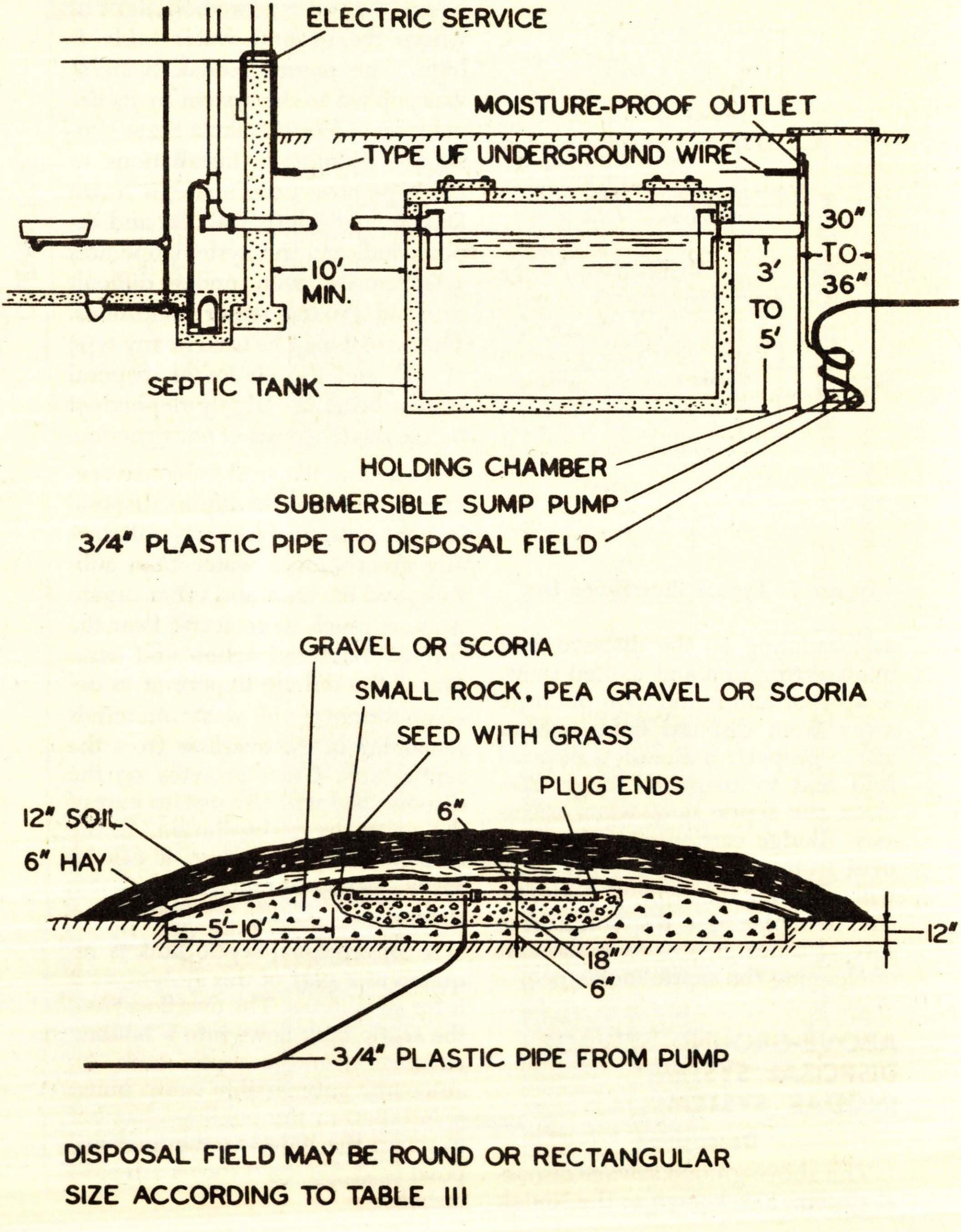

Figure 6. Above-ground disposal system.

Holding Chamber

The holding chamber is usually built near the outlet of the septic tank. It should be of sufficient size to permit a man to work inside. A circular chamber should have an inside diameter of at least 30 inches. The chamber should extend from ground level to a depth of about 3 to 5 feet below the outlet of the septic tank. Concrete culverts, a poured concrete tank, or a sealed concrete block chamber are all suitable construction materials.

Exercise extreme caution in entering a holding chamber which has been in use. The chamber should be well ventilated, using a mechanical fan before entering. A second person should also be present to assist in any emergency.

Pump and Controls

A bronze or cast iron submersible sump pump is recommended. Do not use a standard open motor type sump pump. The submersible sump pump should be equipped with a dependable automatic water level switch.

Use underground Type UF wiring for the electric service to the sump pump. Provide a separate grounded circuit, properly fused. A moisture-proof convenience outlet in the holding chamber will permit easy removal of the pump.

Flexible plastic pipe of three-fourths inch diameter is recommended between the pump and the final disposal field. Lay the pipe below the frost level to prevent freezing, unless the pipe is laid so it will drain between pumping cycles. An extra length of plastic pipe in the holding chamber or a coupling in the discharge line will permit removal of the submersible pump from the chamber.

Disposal Field

The required size of the above-ground disposal field is shown in table 3.

Table 3. Required Size of Above-Ground Disposal Field

No. bedrooms	No. persons	Area req. (sq. ft.)	Dia. of circular field (ft.)
1	2	300	20
2	4	600	30
3	6	900	35
4	8	1,200	40

The field can be round or rectangular and should have a completely flat bottom. Sink the disposal field about 1 foot into the ground to prevent seepage from occurring around the edge of the field.

A drawing of a circular disposal field is shown in figure 6. Dimensions are shown which can be applied to all sizes of disposal fields. Construction of the disposal field will usually include the following steps:

1. Install the plastic pipe from the pumping chamber to a point at the center of the field.
2. Excavate the bottom of the field to a depth of 1 foot. Make sure the bottom is flat.
3. Place 6 inches of coarse gravel on the bottom.
4. Provide a core of aggregate con-

taining no sand, such as crushed rock, pea gravel, or small field stones (3 inches or less in diameter) to a depth of 18 inches above the gravel. The core should extend to within 5 or 10 feet of the outside edge of the field, depending on the size of the field.

5. Install a 6-inch perforated horizonal distribution pipe so the top of the pipe is level with the top of the core. The pipe should be slightly shorter than the width of the core and plugged on both ends. For larger installations, a cross fitting with distributor pipes extending in four directions is recommended. The plastic pipe from the pump should be connected to the distribution pipe or cross at the center with a tight connection using a suitable fitting.
6. Fill the remainder of the bed with coarse gravel to a depth of 6 inches above the distribution pipe.
7. Cover the entire bed with 6 to 12 inches of hay to serve as insulation and to keep the dirt cover out of the gravel and rock. Straw is not recommended.
8. Cover the entire bed with the soil excavated from the bed. This will provide a soil cover of about 12 inches.
9. Seed the bed with a short grass such as bluegrass or crested wheat grass to prevent erosion and to improve the appearance of the installation.

Operation and Maintenance

Little care is required of the above-ground sewage disposal system. Do not drive heavy equipment over the bed. Mow the grass periodically to prevent development of a heavy mat of dead material from developing on the field. Do not allow trees and shrubs to grow on the field, but they may be planted around the unit.

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